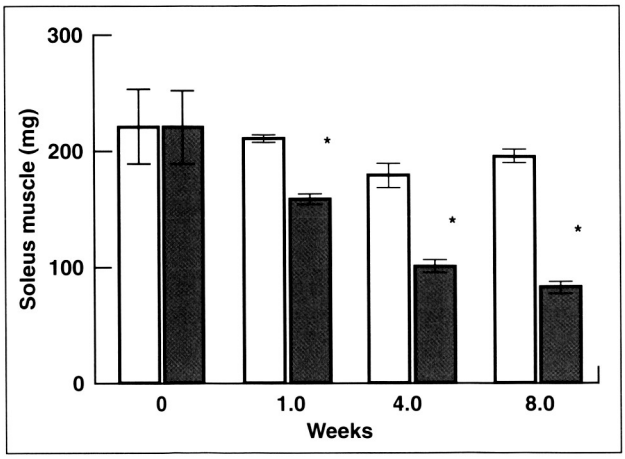

Fig. 2(a). Soleus muscle weights in 400-gram male rats exposed to 8 weeks of hindlimb unloading (shaded) compared to ambulatory controls. Asterisks indicate differences, significance at $p < 0.05$.

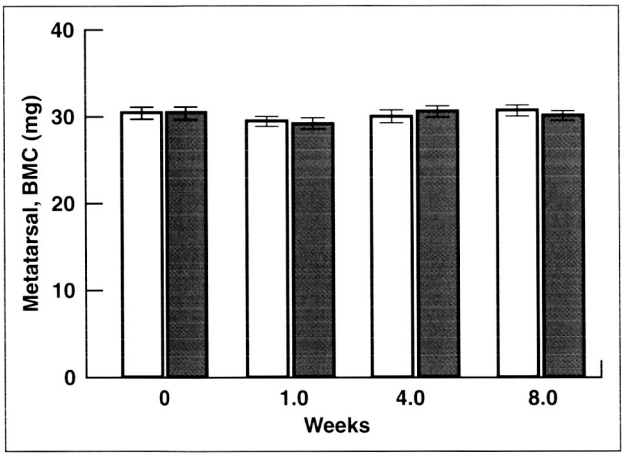

Fig. 2(b). Bone mineral content in the third metatarsal of 400-gram male rats exposed to 8 weeks of hindlimb unloading (shaded) compared to ambulatory controls. None of the apparent differences are significant at $p < 0.05$.

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Inducing Presyncope in Men: A Comparison of Two Stimuli

Patricia S. Cowings, William B. Toscano, Bruce Taylor

NASA has identified cardiovascular deconditioning as a serious biomedical problem associated with long-duration exposure to microgravity in space. High priority has been given to the development of countermeasures for this disorder and the resulting orthostatic intolerance (sudden drop in blood pressure while standing) experienced by crewmembers upon their return to the norm of Earth. This in turn leads to presyncopal symptoms, that is, feeling lightheaded or dizzy just prior to fainting.

The primary purpose of the present study was to directly compare two tests of orthostatic tolerance in normal adult men. The first was a supine lower-body negative pressure (LBNP) test and the second was a combined test of head-up tilt (HUT) and LBNP. In order to test countermeasures for postflight orthostatic intolerance, investigators needed to understand the nature of physiological responses to a gravitational stress. This study would determine which of these types of tolerance tests is best suited for evaluating treatments or countermeasures that will be used to help future astronauts adapt more readily to microgravity as well as to facilitate readaptation to Earth.

Eight men, average age 37.5, were tested. Several physiological responses were measured using the Autogenic-Feedback System-2 (AFS-2), which is designed for monitoring crewmembers in space. Each subject received one supine LBNP test and one HUT + LBNP test, administered at one-week intervals.

The LBNP device is a clear plastic tube (mounted on a tilt-table), which covered the subject's feet and legs while he was lying flat on his back (supine), and was sealed at the waist with a soft rubber strip. Ten minutes of resting baseline data were collected, then the air was removed from the LBNP tube with a vacuum system. Removing the air from the tube had the effect of pulling blood from the subject's upper body down to the legs, resulting in lowered blood pressure as gradually more air was removed at increments of 10 mm Hg (millimeters of mercury) every three minutes. The maximum negative pressure was –100 mm Hg. The HUT + LBNP was essentially

the same as the one described above with one important difference; after the 10-minute resting baseline, the table was tilted upward at the head to 60 degrees for an additional 10 minutes before air was removed from the lower chamber.

Results showed that subjects could tolerate the supine LBNP significantly longer than the combined HUT + LBNP ($p < 0.0004$) (figure 1). There were significant differences between the tests for heart rate ($p < 0.003$), stroke volume ($p < 0.04$), peripheral blood volume ($p < 0.02$), and thoracic fluid volume ($p < 0.016$). In all cases the magnitude of physiological changes from baseline were much greater for the HUT + LBNP than for supine LBNP, that is, higher stress levels than the supine LBNP. The HUT + LBNP can be used to reliably induce presyncope in men; however, data suggest that this device, as used in the present study, produces too strong a stimulus for testing countermeasures when used with normotensive subjects.

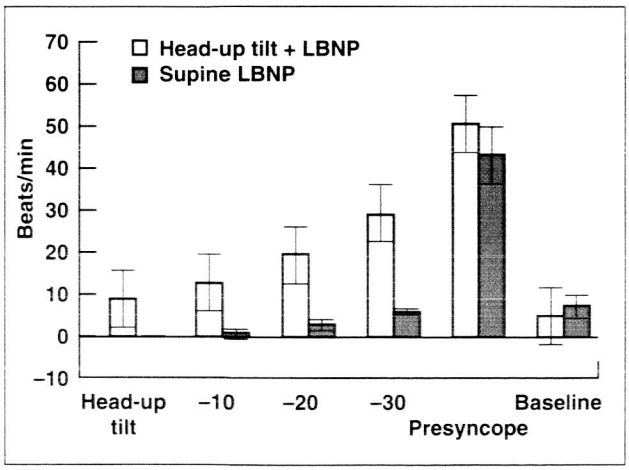

Fig. 1. Heart rate expressed as mean changes from pretest baseline during supine LBNP alone and 60-degree HUT combined with LBNP (N = 8). The x-axis depicts HUT, −10 mm Hg, −20 mm Hg, −30 mm Hg, presyncope (just prior to fainting), and the return to supine during posttest baseline.

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FUNDAMENTAL SCIENCE

Synaptogenesis in Microgravity (NIH.B1)

Deborah Reiss-Bubenheim, Paul Savage

The flight experiment National Institutes of Health.Biology 1 (NIH.B1) was flown on the space transport system (STS-93) in late July, 1999. NASA Ames Research Center collaborated with BioServe Space Technologies, a NASA-sponsored Commercial Space Center (CSC), to develop an enhancement to the Group Activation Package (GAP) and the Isothermal Containment Module (ICM), shown in the first figure, flown within the Commercial Generic BioProcessing Apparatus (CGBA) payload. The collaboration evolved from the needs of both organizations to fly middeck experiments on the STS-93 mission. The NIH.B1 experiment was entitled "Effects of Spaceflight on Drosophila Neural Development," and was led by Principal Investigator, Haig Keshishian, Harvard. This experiment was designed to investigate the effects of microgravity on a transgenic fruit fly line that expresses green fluorescent protein (GFP) to visualize singly identified motoneurons and their muscle targets, as shown in the second figure.

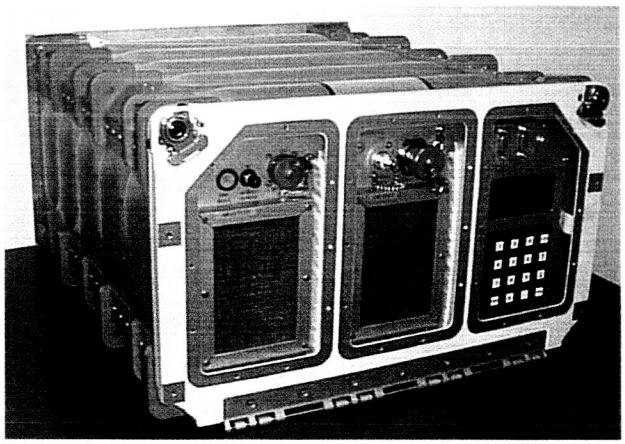

Fig. 1. The Isothermal Containment Module (ICM) used in STS-93.